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ABSTRACT

This study explores the effectiveness of an instructional strategy which displays appropriate knowledge structures versus a learning strategy that engages learners in defining knowledge structures by comparing the effects of providing graphical organizers in the form of completed frames with requiring students to complete frames as a study strategy prior to examinations. The learning variable being investigated is structural knowledge, i.e., the knowledge of how concepts within a domain are interrelated. The subjects were 56 students from a general psychology course at a large community college in Denver, Colorado, who were divided into two groups. Three subject-matter exams were designed to test recall of the text and lecture material, and subscales were developed to measure three aspects of structural knowledge: relationship proximity judgments, semantic relationships, and analogies. Students were also asked to complete a questionnaire assessing the extent of use and helpfulness of the instructor-provided and student-generated maps. Analyses of the data showed that both groups improved their relationship knowledge by focusing on the relationships when using the instructor-provided graphic organizers, and structural knowledge acquisition improved significantly. Between the second and third exams, however, an apparent task-by-group interaction occurred as Group 1 relationship scores appear to have benefited more from the learning strategy than Group 2 scores. Factors that may have influenced the results include the treatment, the content or test difficulties, and the difficulty of the mapping exercise. (12 references) (BBM)

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Learner-Generated vs. Instructor-Provided Analysis of Semantic Relationships

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Learner-generated vs. Instructor-provided Analysis of Semantic Relationships

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Learning and Semantic Networks

Our semantic networks represent our knowledge structures which enable learners to combine ideas, infer, extrapolate or otherwise reason from them. Learning consists of building new structures by constructing new nodes and interrelating them with existing nodes and with each other. The more links that can be formed between existing knowledge and new knowledge, the better the information will be comprehended and the easier learning will be. Learning, according to semantic network theory, is the reorganization of the learner's knowledge structure. During the process of learning, the learner's knowledge structure begins to resemble the the knowledge structures of the instructors, and the degree of similarity is a good predictor of classroom examination performance (Diekhoff, 1983; Shavelson, 1974; Thro, 1978). Instruction then may be conceived of as the mapping of subject matter knowledge (usually that possessed by the teacher or expert) onto the learner's knowledge structure.

If we accept the conception that learning is involves the reorganization of the learner's cognitive structure, then instruction involves the assimilation of the expert's knowledge structure by the student. In order to help students reorganize and tune their knowledge structures, we need instructional strategies for depicting and displaying appropriate knowledge structures to students and tools for organizing their knowledge structures. Instructional strategies may illustrate or convey appropriate knowledge structures to students, whereas the tools or learning strategies may help learners to acquire and refine their own knowledge structures (Jonassen, Beissner, & Yacci, in press). This study compares the effectiveness of an instructional strategy which displays appropriate knowledge structures with a learning strategy that engage learners in defining knowledge structures. The former strategy illustrates key concepts and their interrelationships where the latter requires the learners to identify and classify relationships between key concepts, which plae more intelectual responsibulity onto the students for meaning-making.

The learning variable that is being investigated here is structural knowledge. Structural knowledge is the knowledge of how concepts within a domain are interrelated (Diekhoff, 1983). Structural knowledge enables learners to form the connections that they need to describe and use scripts or complex schemas. It is a form of conceptual knowledge that mediates the translation of declarative knowledge into procedural knowledge.

Instructional Strategies vs. Learning Strategies

An instructional strategy is a method or technique for providing instruction to learners. They are implemented through instructional teactics (Jonassen, Grabinger, & Harris, 1991). For instance, an instructional strategy may recommend motivating the learner prior to instruction, which may call for tactics such as arousing learner uncertainty, asking a question or presenting a picture. A strategy aimed at teaching a concrete concept may call for the use of tactics such as matched example-nonexample pairs or deriving the criterion attributes from a set of examples. Instructional strategies provide the overall plan that guides the selection of instructional tactics that facilitate learning. Instructional strategies may be divided into four main classes: contextualizing instruction, providing learner control, organizing and cueing learning, and assessing and evaluating learning. Instructional strategies are instructor-provided interventions that are meant to stimulate learner processing of information.

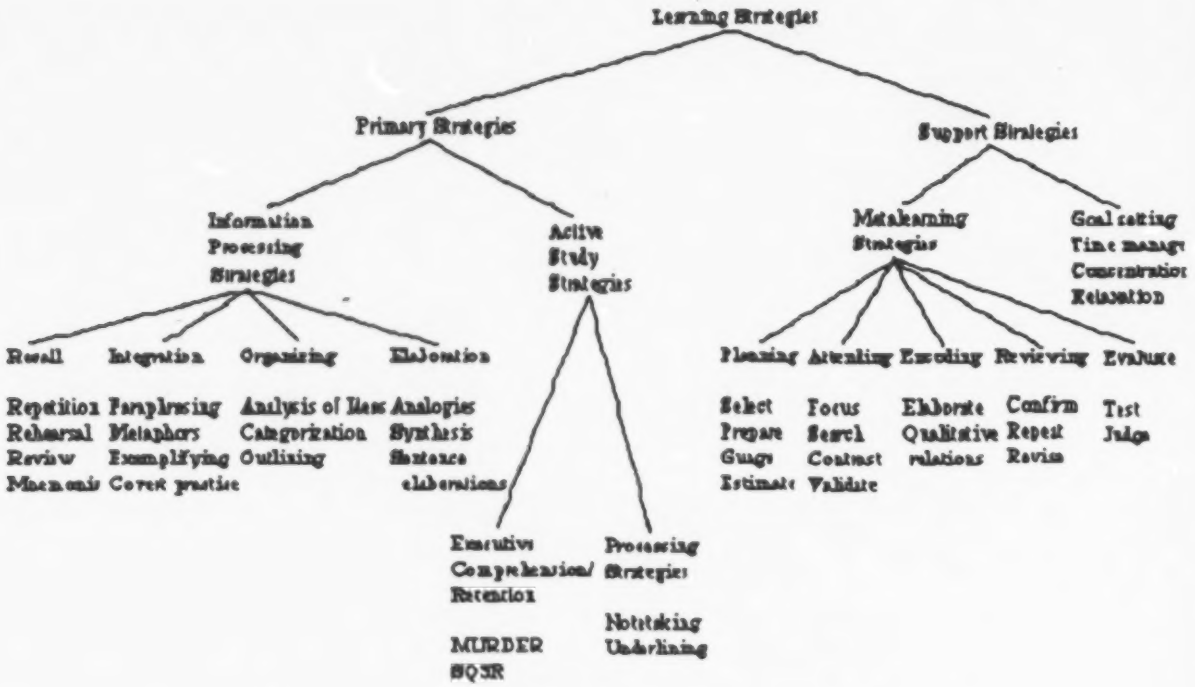

Figure 1

Learning strategies are mental operations that the learner may use to acquire, retain and retrieve different kinds of knowledge or performance. Figure 1 presents a taxonomy of learning strategies that may be used by learners to integrate new information into their knowledge structures and restructure and synthesize that knowledge. The fundamental difference between instructional strategies and learning strategies is that the former are largely mathemagenic and the latter are generative (Jonassen, 1985). Mathemagenic instructional strategies control the processing of learners while leading them to learning, so they result in anticipated learning outcomes. They facilitate acquisition of specific content knowledge (intentional learning) but generally do not affect or even impede the acquisition of any other knowledge (incidental learning).

Learning strategies, on the other hand, are generative, that is, they enable learners to take an active, constructive role in generating meaning for information by accessing and applying prior knowledge to new material. Wittrock's (1978) generative hypothesis asserts that meaning for material presented by computer or any other medium is generated by the learner's activating and altering existing knowledge structures in order to interpret what is presented. Cognitive learning strategies are intended to increase the number of links between presented information and existing knowledge. Learning strategies, unlike instructional strategies, are learner-controlled as well as learner-generated. They engage the learners and help them to construct meaningful representations, and their success depends upon the learner taking an active role in controlling their use.

Instructional and Learning Strategies for Facilitating Structural Knowledge

There are a number of instructional strategies for conveying structural knowledge representations and therefore affecting the way that learners encode these structures into memory. There are also a number of learning strategies that learners can use to build their own structural knowledge representations (Jonassen, Beissner, & Yacci, in press). Instructional strategies include explicit graphic, mapping techniques, such as graphical organizers, spider maps, semantic maps, and causal interaction maps, for conveying knowledge structures to students. Teachers and designers may use a number of verbal instructional techniques, such as content structures and elaboration theory, to convey the underlying structures in materials to students. A number of graphical learning strategies, such as networking and pattern noting, may be used by learners to build their own knowledge representations. Among these strategies, one of the most effective is a study strategy called the *Frame Game* that was developed to accompany an educational psychology textbook (Clifford, 1981). The Frame Game is a text processing strategy that identifies the most important concepts in a textbook chapter and then requires the learner to identify the relationships between the concepts by assigning them to predetermined, mapped relationships (see Figure 2). This analysis strategy requires that learners search, contrast, validate, elaborate, confirm, and test information from the chapter. These relationship maps may be used to engage learners in generative processing of textual information or to depict the information. In this study, we compare the provision of structural information to learners as a review of the information with the learner analysis of the relationships between the concepts in the chapter.

The arrangements of boxes in Figure 2 represent different relationships between concepts, such as hierarchical, sequential, and associates relationships. Students have to analyze the concepts and decide which combinations can fit into the structures. Such an activity requires deep level semantic analysis of the main ideas in each book chapter.

Purpose of Study

The primary purpose of this study was to compare the effects of a structural knowledge instructional strategy with the effects use of a structural knowledge learning strategy on the acquisition of structural knowledge. Specifically, we wanted to compare the effects of providing graphical organizers in the form of completed Frames with requiring students to complete Frames as a study strategy prior to examinations.

Method

Subjects

Fifty-six students from two sections of a General Psychology (Psy 101) course at a large community college in metropolitan Denver completed the study. Ten other students failed to complete all of the tests so were dropped from the analysis. There were 27 subjects in the Group 1, and 28 in Group 2.

Instruments

Three subject-matter exams were designed for the experiment. Each exam consisted of 60 questions worth one point each, 37 of which were multiple-choice questions testing recall and comprehension of the text and lecture material. In order to assess structural knowledge acquisition following various treatments, we developed three subscales to measure different aspects of structural knowledge: a) 10 relationship proximity judgements, b) 8 semantic relationships, and c) 5 analogies. All of the structural knowledge test questions were developed to focus on relationships between important concepts contained in the textbook chapters.

The relationship proximity judgments required that students judge the strength of the relationship between two terms and assign a number between 1 and 9 to each of several pairs of concepts to indicate how strong a relationship they thought existed between the concepts in each pair

(Diekhoff, 1983; Schvaneveldt, Durso, Goldsmith, Breen, Cooke, Tucker & DeMaio, 1985; Shavelson, 1972). For example:

_____ 2. endorphins -- amygdala

_____ 3. cerebral cortex -- Broca's area

_____ 4. seratonin -- temporal lobe

The semantic relationships subscale consisted of eight multiple choice questions that required students to understand and recognize the nature of the relationship between two concepts. These relationships were paraphrased from the text book. For example:

_____ 16. sensory registers .... short term memory
- a. precedes
- b. is defined by
- c. is independent of
- d. is inferred by

_____ 17. acoustic .... memory
- a. results in
- b. is independent of
- c. is opposite of
- d. is an example of

Finally, the analogies subscale required students to complete 5 analogies consisting of four of the concepts from the hypertext. For example:

_____ 22. decay : forgetting :: ..... : retrieval

- a. mood
- b. repression
- c. rehearsal
- d. primacy

_____ 23. acquisition : extinction :: punishment : .....

- a. negative reinforcement
- b. positive reinforcement
- c. variable reinforcement
- d. classical conditioning

These questions were used to assess structural knowledge acquisition. In order to provide standards for assessment, the researchers agreed on the answers to each of these questions. Answers to the multiple choice questions were recorded on the front of Scantron answer sheets; semantic-proximity items were written on the back. Exams covered history and methodology of psychology (chapters 1 & 2), physiology, sensation and perception (chapters 3 & 4), and learning and memory (chapters 6 & 7).

Materials

A list of researcher-generated key concepts and terms was generated for each chapter to be used as student study aids; terms were drawn from the textbook, instructor notes and examinations during the previous semester. Researcher-generated study maps were generated for chapters 3, 4, 6, and 7; mapping allowed students to visualize the relationships among terms — superordinate (hierarchical) and sequential organization, as well as the depiction of the terms in classes, analogies, similarities, cause and effect, and opposites (see Figure 2). Templates of maps were designed for a student-generated-mapping exercise to be assigned prior to Exam 3. These maps were the same as the instructor provided maps in Figure 2 except that most of the locations in the maps were empty, requiring the student to fill in the appropriate concepts.

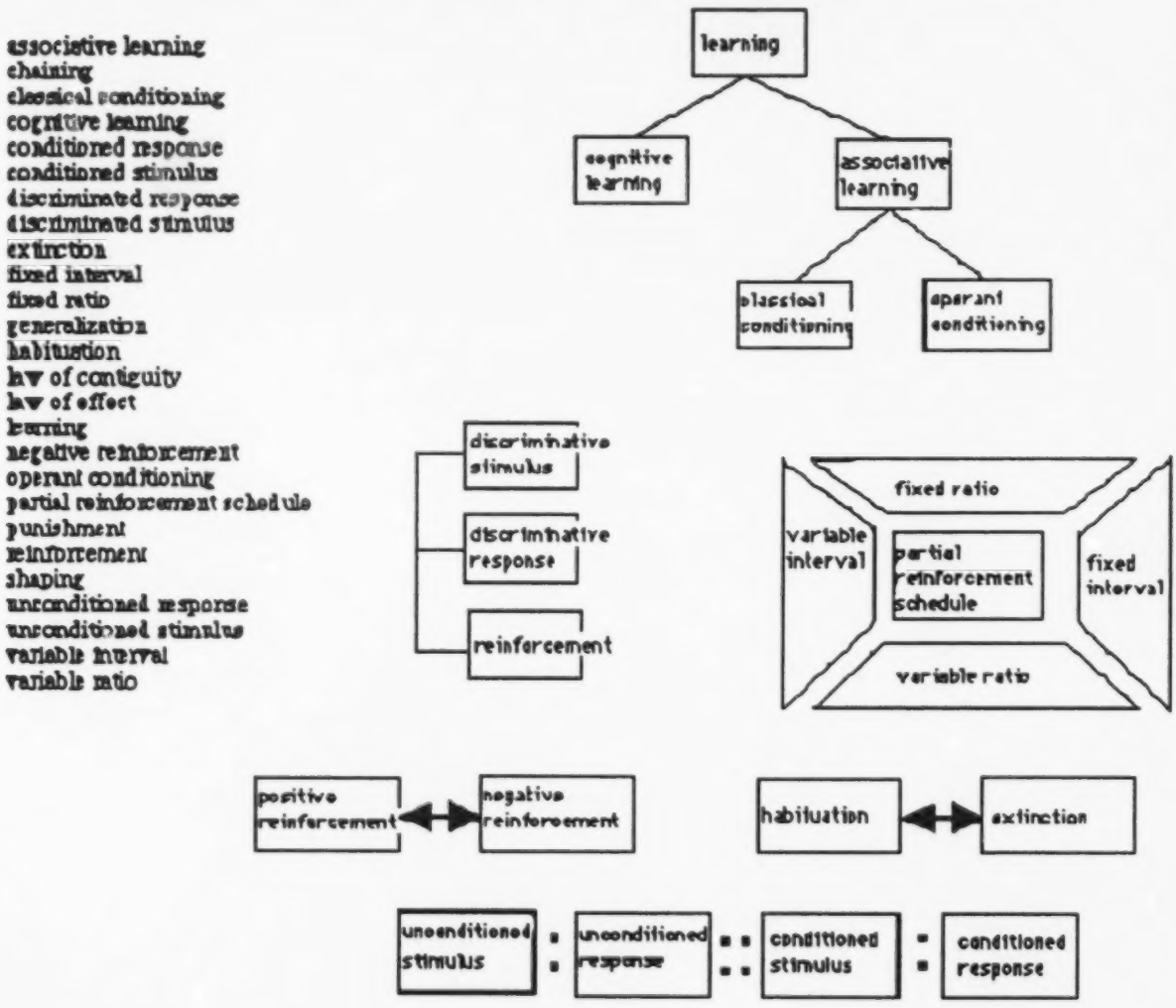

Figure 2

Procedure

The study was a quasi-experimental design using intact psychology classes. The classes met three times a week at 10:00 (Group 1) and 1:00 PM (Group 2). One of the researchers served as instructor for both sections of the course.

A counterbalanced design was used to control for practice effect and chapter difficulty.

	Group 1	Group 2
Exam 1: Baseline	Chapters 1, 2	Chapters 1, 2
Exam 2: Maps Provided	Chapters 3, 4	Chapters 6, 7
Exam 3: Maps Generated	Chapters 6, 7	Chapters 3, 4

One week prior to Exam 1, a study sheet containing the key terms from lecture and text was distributed. Exam 1 was administered to both groups at the beginning of the 4th week of class. It covered chapters 1 and 2 (history & methodology) and served as the within-group control measure.

At the end of the 4th week (2 sessions after Exam 1) the investigators informed the students that they would be involved in a study about using learning strategies that would help them improve their learn skills.

One week prior to Exam 2, a list of key terms and an instructor-generated map of terms (graphical organizer, Figure 3) was distributed to students; 30 minutes of class time was devoted to explaining the mapping rationale. Exam 2 was administered at the beginning of the 8th week of class. Group 1 was tested on chapters 3 and 4 (physiology, sensation & perception); Group 2 was tested on chapters 6 and 7 (learning & memory). During the class period following the exam, the instructor reviewed the exam and administered a questionnaire assessing the extent of use and helpfulness of the instructor-provided maps.

A week prior to Exam 3, a list of key terms and a student-generated mapping exercise were distributed to students; 30 minutes of class time was devoted to the procedure of generating maps. Students were assigned to complete the maps for homework. The following class period, the student-generated maps were collected. They were evaluated on a 9-point Likert scale and returned at the next class, which was devoted to review and to helping students complete the maps of difficult items. Then students were given copies of the same maps which had been distributed to their counterparts for Exam 2. Exam 3 was administered at the start of the 12th week of classes. Group 1 was tested on chapters 6 and 7 (learning & memory); Group 2 was tested on chapters 3 and 4 (physiology, sensation & perception). During the class period following the exam, the instructor reviewed the exam and administered a questionnaire assessing the extent of use and helpfulness of the student-generated and instructor-provided maps.

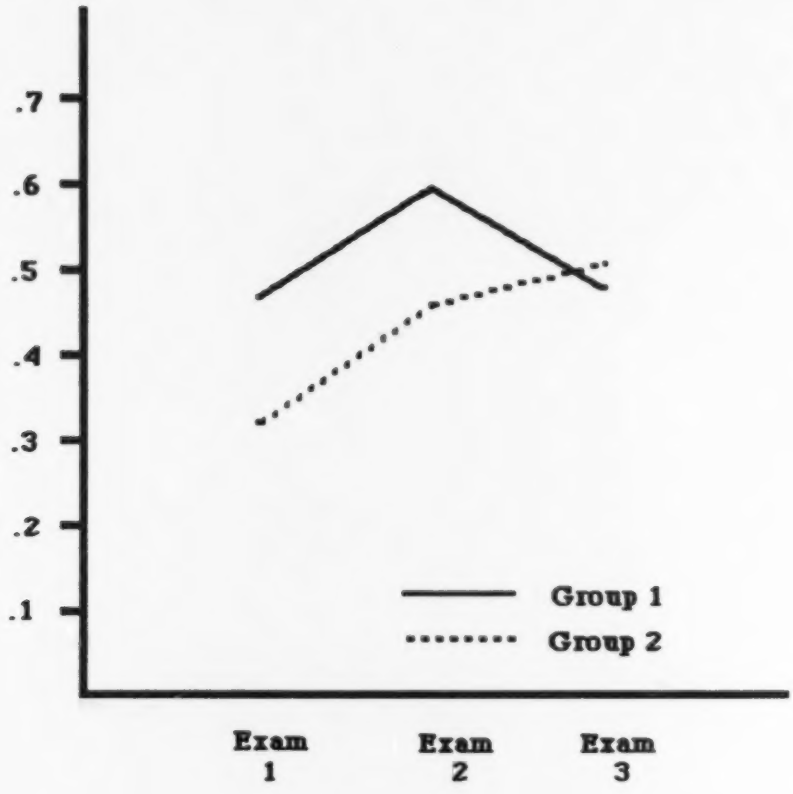

Figure 2
Mean Proximity Correlations by Exam

Figure 2

Results

The semantic proximity scores for each of the students completing all three exams were correlated with the expert ratings, yielding a correlation coefficient for each subject. These coefficients and the relationship scores (0-8), analogy scores (0-5), and the recall/comprehension items (0-37) were all analyzed using a repeated measures analysis of variance (ANOVA). The means for the proximity scores by group are illustrated in Figure 3, and the relationship and analogy scores are illustrated in Figure 4.

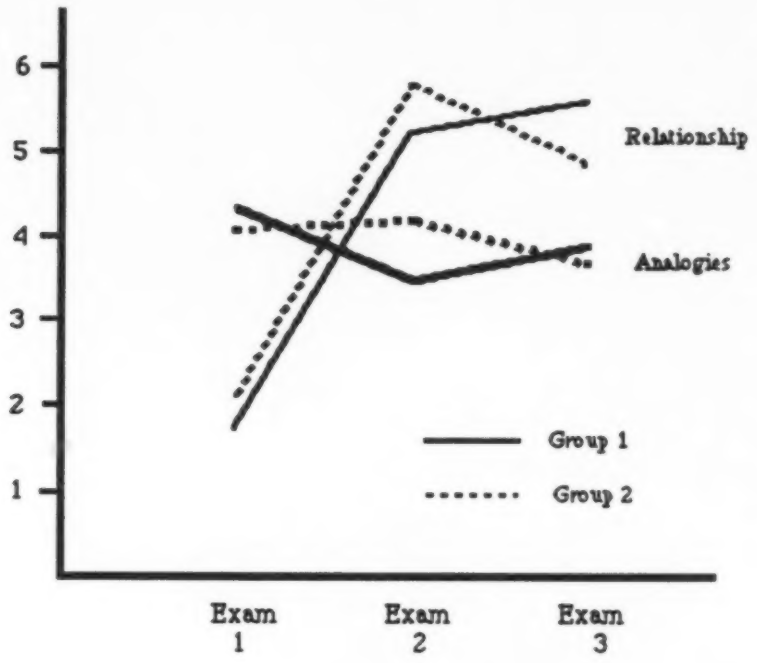

Figure 3
Relationship and Analogy Scores by Exam

The ANOVA calculated on the proximity correlations indicated that Group 1 significantly outperformed Group 2 (Table 1). This was especially true on the first and second exams. Note that this question type was new to students on the first exam. Howeve, a significant interaction occurred between the second and third exams. Group 1 appeared to be adversely affected by the generative learning strategy which appears to have significantly benefitted Group 2 students.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	.601	.601	4.432	.0402
subjects w. groups	51	6.915	.136		
Repeated Measure (B)	2	.348	.174	2.274	.1081
AB	2	.72	.36	4.713	.011
B x subjects w. groups	102	7.797	.076		

Table 1
ANOVA on Mean Proximity Correlations

On the relationship scores, no main effect for group occurred; however, a significant main effect occurred for the repeated measures (Table 2). It is obvious from Figure 4 that both groups improved their relationship knowledge by focusing on the relationships when using the instructor-provided graphic organizers. Structural knowledge acquisition improved significantly. Between the second and third exams, an apparent task-by-group interaction occurred ($p<.05$). Group 1 relationship scores appear to have benefitted more from the learning strategy than Group 2 scores.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	.183	.183	.074	.7865
subjects w. groups	51	126.043	2.471		
Repeated Measure (B)	2	414.503	207.252	128.225	.0001
AB	2	13.966	6.983	4.32	.0158
B x subjects w. groups	102	164.864	1.616		

Table 2
ANOVA on Relationship Scores

The analogy scores changed significantly across exams. Group 2 increased, then decreased, while Group 1 decreased then increased. A similar interaction effect occurred on the analogy scores (Table 3). Group 1 scores improved significantly from the second to the third exam.

Source:	df:	Sum of Squares:	Mean Square:	F-test:	P value:
Group (A)	1	1.484	1.484	.812	.3719
subjects w. groups	51	93.245	1.828		
Repeated Measure (B)	2	20.994	10.497	13.082	.0001
AB	2	17.162	8.581	10.694	.0001
B x subjects w. groups	102	81.844	.802		

Table 3
ANOVA on Analogy Scores

In attempting to explain the effects that occurred in the study, all of the possible factors need to be analyzed. The possible causal factors include the treatment (organizer vs. learning strategy), the content or test difficulty, and individual differences between the groups. There was no significant difference between the groups in terms of their preferences for structuring materials (field independence) as measured by the Hidden Figures Test (Ekstrom, French & Harmon, 1963). There was good reason to believe that content difficulty may be a factor. Group 1 experienced more difficulties on the second exam covering chapters 3 and 4 while Group 2 experienced similar difficulties on the third exam which covered the same chapters.

In order to test this hypothesis, we examined the total exam scores including all of the subscales. Total scores on the exams increased proportionately for both groups from the first to the second exam; however, Group 2 scores decreased significantly on the third exam. This would tend to discount the content difficulty argument. No significant differences in the recall/comprehension scores occurred. Since the strategies focused on the acquisition of structural knowledge, this finding was expected. The interaction between group and repeated measures was significant however (F=4.06, p<.05). The performance for Group 1 was consistent across exams while Group 2 scores decreased significantly on the third exam. This would indicate that either the test and/or the material was more difficult overall or that recall was adversely affected by the learning strategy.

At the end of the seester, students completed a recall/comprehension examination over the entire semester's material. Each of the items in the exam were classified by the exam (and therefore the treatment) they were derived from. These questions comprise a recall/retention test

of the content learned under each of the treatments. The retention scores showed the same pattern as all of the structural knowledge questons in the chpater tests. A repeated masure ANOVA showed no main effects but a significant group-by-treatment interaction ($F=17.65$, $p<.001$). Retention scores were equivalent for maerials from the first exam, Group 1 decline on material from the second exam (Chapters 3 and 4, M=7.7) and improved on material from the third (Chapters 6 and 7, M=10.2) while Group 2 had the opposite effect (M=10.0 and 7.4). Clearly, the material from chhapters 3 and 4 was more difficult than that from chapters 6 and 7.

Discussion

A number of factors seem to have affected the learning of material in this experiment. One of the most obvious is the difficulty of the material. Clearly the material in Chapters 3 and 4 (physiology, sensation, and perception) was more difficult than that from Chapters 6 and 7. The former discussion was more technical and less related to the student's prior knowledge. It is easier to relate learning and memory concepts to a class of college students.

However, difficulty of the material was not the only cause of the results. Since immmediate recall and comprehension performance was not appear to be affected by the content for Group 1. Their recall scores were essentially equal. Group 2 however was more affected. In addition to content difficulty, their decreased performance was also caused in part by motivational deficiencies. Group 1 examination performances tended to exceed that of Group 2. This might be explained by any of several factors, or a combination thereof. First is intrinsic motivation. At this college, afternoon classes (Group 2) are generally more lethargic and less academically motivated than morning classes; frequently the students in the afternoon classes enroll just before the term begins (attending college is more of an afterthought). Second is extrinsic motivation. Although students were asked to complete the mapping exercise, they did not receive any course credit for doing so. 13 of 27 students in Group 1, but only 9 of 28 students in Group 2 mapped both chapters for the third exam. Future studies should assign course credit based on the quality of maps generated. Another issue related to extrinsic motivation is the fact that the instructor curved the students' grades on each exam. Thus, the students in Group 1, which scored higher than Group 2, were forced to master more of the material if they wanted to earn high grades. In future studies, grades should not be curved.

Another issue relates to the difficulty of the mapping exercise. The exercise may have placed too great a cognitive load on students. The 30 minutes instruction in completing the maps was probably inadequate; we believe that future studies should provide practice in generating maps of familiar material before students are asked to generate maps of new material. Furthermore, they probably needed more scaffolding in completing such exercises. For example, the list of key concepts should contain only the terms which can actually be used to complete the maps; in this study, students received a list of all of the concepts they were responsible for, but many of these were not addressed by the maps. Since it appears that students acquired more benefit from being provided with completed maps than having to generate their own (these maps provided scaffolding for relating and remembering the material) and generating maps was a new learning strategy for the students, they did not have time to learn how to incorporate this study strategy in just a few days; Duffy and Roehler (1989) suggest that it takes months for a new learning strategy to displace a well-established old one. To give students time to incorporate the strategy into their repertoires, future studies should utilize a single strategy for an entire semester.

Students' reactions to the two strategies also suggests the need for further investigation. At least 77% of the students in each class said they found the maps to be "somewhat helpful" or "very helpful" study aids. But as Clark (1982) found in an earlier study, there appears to be a achievement and enjoyment; 67% of the survey respondents in Group 1 (44% of the total group) preferred being given maps, while 64% in Group 2 (32% of the total group) preferred having to construct maps. Most of the students who preferred being given maps commented that having to complete the maps forced them to pay closer attention to the material. Whether students'

preferences and achievement would change with less difficult mapping exercises and more training in mapping must be studied.

Another question relating to the use of the maps is the nature of the cognitive processing students used. Did they engage in rote memorization or perhaps some form of verbal mediation such as self-explanations or comparative elaborations? Future studies should include debriefing sessions to try to identify the types of processing students used.

Students' performances on the relationship items suggests that verbal competency might have played a role. During the exams, several students asked the instructor the definition of words (e.g., "exemplifies"). Future studies should assess students' verbal competency to determine if it influences their performance on the examinations.

Finally is the issue of content difficulty. For the total scores there was no group by test interaction, but for the structural-knowledge items there was. This suggests that there was an interaction for content by cognitive task difficulty. That is, it may have been more difficult to assimilate structural knowledge for chapters 3 and/or 4 than for chapters 6 and 7. Chapter 4 did not have a single organizing structure; thus no hierarchical map was provided for that chapter; the lack of such a structure may have contributed to the depressed structural knowledge scores on that examination. Further analysis of the content of test items for chapters 3 and 4 is needed.

References

Clark, R. E. (1982). Antagonism between achievement and enjoyment in ATI studies. *Educational Psychologist, 17* (2), 92-101.

Clifford, M. (1981). "The frame game". Supplement to *Practicing educational psychology.* New York: Houghton Mifflin.

Diekhoff, G. M. (1983). Testing through relationship judgements. *Journal of Educational Psychology, 75*, 227-233.

Duffy, G. G., & Roehler, L. R. (1989). In. C. McCormick, G. Miller, & M. Pressley (Eds.), Why strategy instruction is so difficult and what we need to do about it. *Cognitive strategy research: From basic research to educational applications* (pp. 133-154). NY: Springer-Verlag.

Ekstrom, R.B., French, J.W., & Harman, H.H. (1976). *Manual for the kit of factor referenced cognitive tests.* Princeton, NJ: Educational Testing Service.

Jonassen, D.H. (1985). Learning strategies: A new educational technology. *Programmed learning and Educational Technology, 22*(1), 26-34.

Jonassen, D.H., Beissner, K., & Yacci, M. (in press). *Structural knowledge.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Jonassen, D.H., Grabinger, R.S., & Harris, N.D.C. (1991). Instructional strategies and tactics. *Performance Improvement Quarterly, 4*(1),

Schvaneveldt, R.W., Durso, F.T., Goldsmith, T.E., Breen, T.J., Cooke, N.M., Tucker, R.G., & DeMaio, J.C. (1985). *Measuring the structure of expertise.* Las Cruces, NM: Computing Research Laboratory, New Mexico State University.

Shavelson, R. (1974). Methods for examining representations of subject matter structure in students' memory. *Journal of Research in Science Teaching, 11*, 231-249.

Thro, M.P. (1978). Relationships between associative and content structure of physics concepts. *Journal of Educational Psychology, 70*, 971-978.

Wittrock, M.C. (1978). The cognitive movement in instruction. *Educational Psychologist, 15*, 15-29.